
Space Weather Technical Forecast

Issued on Monday 24 February 2025 at 01:06 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: M-class flares likely. Possible glancing CME Day 1 (24 Feb), chance of G1.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been High with one X-flare, peaking at X2.0 at 23/1927 UTC, most likely from AR4001 over the NW limb. There are now nine sunspot regions on the visible disc. AR4001 was likely responsible for the largest flare of the last 24 hours, but is no longer visible on the northwest limb. Otherwise, the most notable regions remain AR3998 in the southwest quadrant and AR4000 in the northwest quadrant. AR3998 has shown spot development, increasing in penumbral area, with mixed polarities in the intermediate portion. However, it does not currently have a clear delta spot. AR4000 developed rapidly at first although this has now stalled, showing some slight decay in its intermediate spots. However, there remains a delta region in the trailing portion. AR3996 appears to be in slight decay. The other regions on the disc do not currently appear particularly complex.

A CME was observed off the northwest limb in association with the X2.0 flare, but is unlikely to have any Earth-directed impact.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1, showed background conditions. Wind speeds varied between 300-360 km/s. Density was initially below average, rising to average late on 23 Feb. Interplanetary Magnetic Field, Bt, was mostly weak at or below 8nT. A possible transient CME arrival late on 23 Feb saw a rise to 13 nT. The north-south component, Bz, initially varied weakly between +6 and -2 nT, before increasing later to vary between -9 and +11 nT. Phi angle was predominantly positive (away from the Sun). Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was near or just very slightly above normal background levels. High energy electron flux (greater than 2MeV) at GOES16 was at moderate to background levels. The associated 24-hour fluence was below the Active threshold (1e8 integrated pfu) on a slight declining trend, recording 4.76e6 integrated pfu at 24/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate solar activity is forecast, with isolated M-flares considered likely and a slight chance of X-flares.

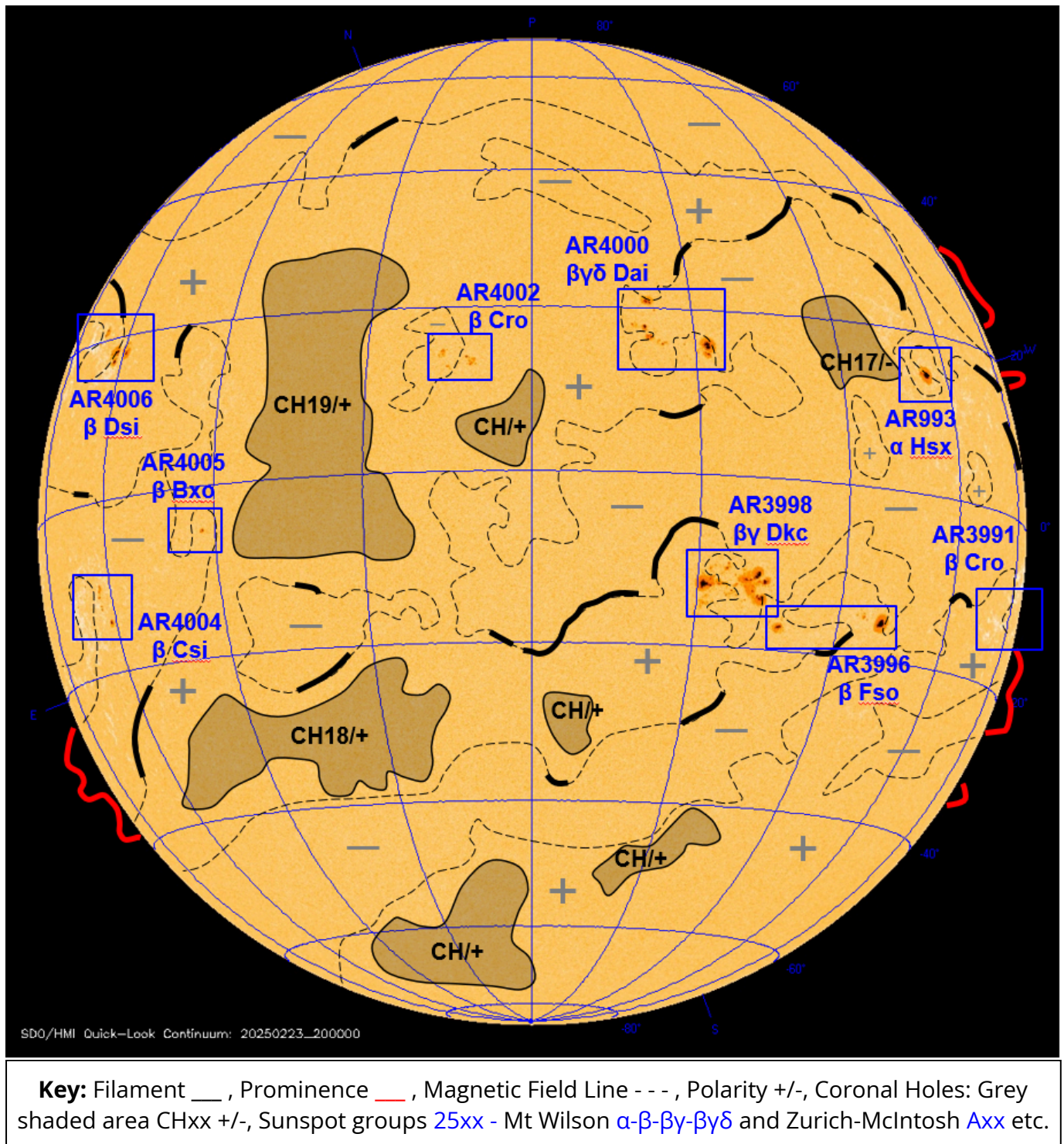
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

Solar Wind / Geomagnetic Activity: There are two main CMEs in the forecast at present. The first may have arrived as a transient feature late on 23 Feb, with the second forecast to reach Earth during Day 1 (24 Feb). Overall, confidence in the CME forecast remains low, however recent observations from Solar Orbiter suggest the second CME could be stronger than the first. Wind speeds are currently at background levels. Late Day 1 or Day 2 (24-25 Feb) a slight enhancement may occur, associated with CH17/-, with wind speeds perhaps reaching around 400-450 km/s.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled (Kp1-3), but activity may increase to give a chance of G1/Minor Storm (Kp5) and a slight chance of G2/Moderate Storm (Kp6) intervals early on Day 1, this risk increasing further with any second CME arrival later Day 1. Activity gradually reducing back to Quiet from Day 2 (25 Feb).

Energetic Particles / Solar Radiation: High energy proton flux has a chance of reaching S1/Minor radiation storm levels in response to the recent X2.0 flare. In the absence of any increase from this event, proton flux is most likely to remain at background levels, but with a slight chance of rising in response to any further large flares. High energy electron flux is expected to be mainly at background to moderate levels. The associated 24 hour fluence is expected to remain below the Active ($1e8$ integrated pfu) threshold.

Figure 1: Solar Synoptic Map valid 23/2000 UTC.



Geomagnetic Storms

There have been several CMEs over the last few days, some of which are difficult to assess in coronagraph imagery. There are two main features which could have an Earth directed component. The first followed a C8 flare at 19/2345 UTC from a now decayed region in the southwest, with an arrival originally forecast for the middle of the day (UTC) on 23 Feb. A second CME is forecast to reach Earth during Day 1 (24 Feb). Overall, confidence in the CME forecast remains low, although recent observations from Solar Orbiter suggest there are two CMEs incoming and the second CME could be stronger than the first, however given Solar Orbiter's position near to Venus, these may well both miss behind Earth's orbit. A recent increase was observed at L1 in the Interplanetary Magnetic Field, becoming briefly moderate in the negative (southward) direction, possibly as part of the first CMEs magnetic cloud reaching Earth as a transient arrival.

Wind speeds are currently at background levels. Late Day 1 or Day 2 (24-25 Feb) a slight enhancement may occur, associated with CH17/-. This is a small, weak feature seen in imagery, and at most wind speeds may become slightly elevated around 400-450 km/s. As CH17 is negative polarity and the March equinox is approaching, if a connection occurs there may be a slightly greater geomagnetic response to a weak High Speed Stream (HSS) than normally expected. Earth's current position to the south of the solar equator does lessen the chance of any connection however. Larger coronal holes in the eastern hemisphere are unlikely to connect to Earth within this forecasting window, however a number of smaller coronal holes ahead of these have appeared to open up in recent imagery. These have the potential to enhance solar winds towards the end of Day 4 (27 Feb). Enlil is currently overestimating wind speeds and is likely to continue to do so over the next few days.

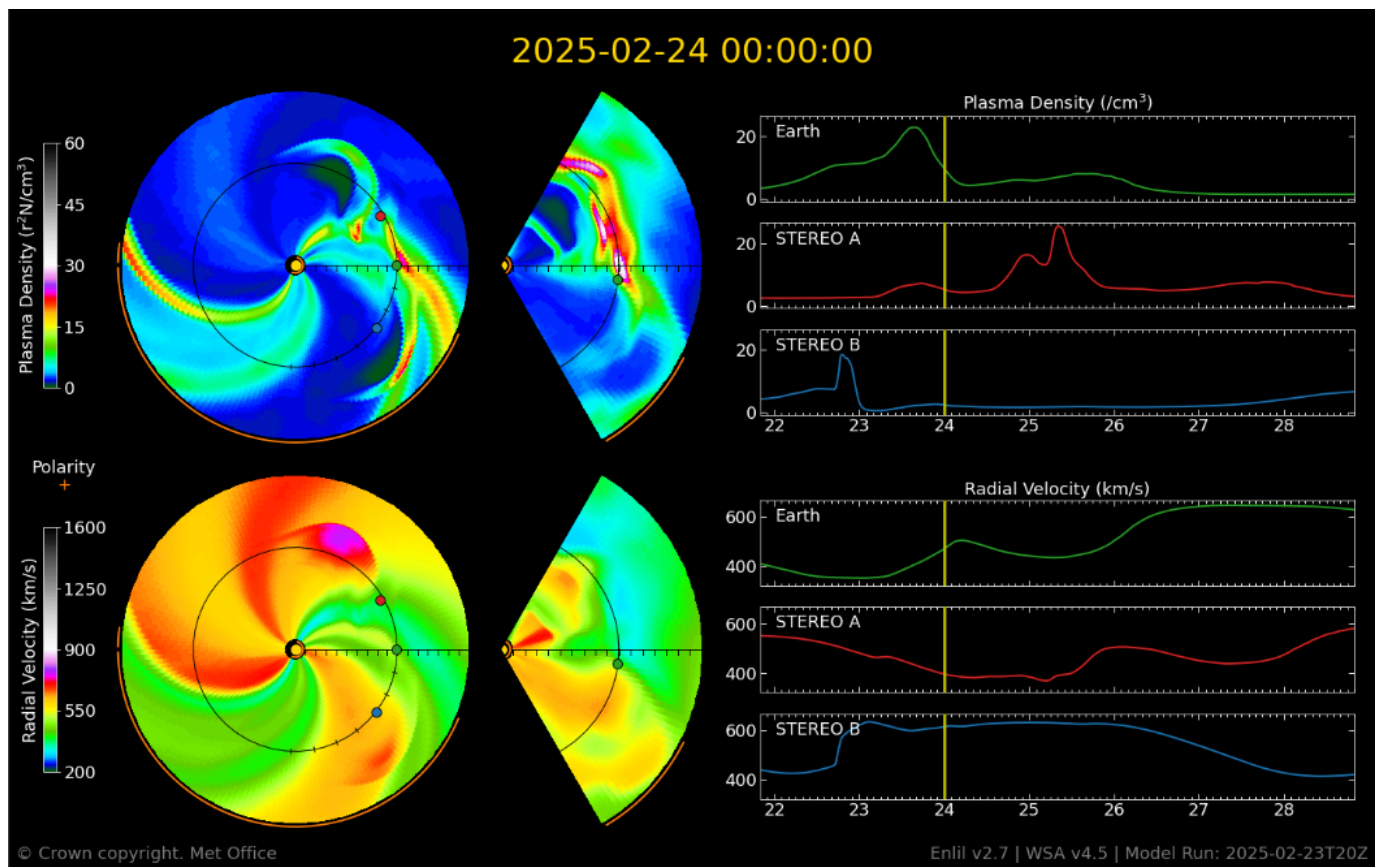
Geomagnetic activity is forecast to be mainly Quiet to Unsettled (Kp1-3), but activity may increase to give a chance of G1/Minor Storm (Kp5) and a slight chance of G2/Moderate Storm (Kp6) intervals early on Day 1, this risk perhaps increasing further with any second CME arrival later Day 1. Activity gradually reducing back to Quiet from Day 2 (25 Feb).

Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	50	20	5	5
Strong	G3	No	10	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R _☉ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
20/0514	Partial	ex-AR3991	SW	438	23/1200UTC +/-9 hours	Possible weak arrival late 23 Feb.
20/2200	Partial	Uncertain, maybe near AR3996	Uncertain	450	24/1200UTC +/- 6 hours	Potentially a stronger CME than the first.

Figure 2: MOSWOC Enlil, showing possible CME glances 24 Feb. Enlil likely overestimating solar wind speeds.



Radio Blackouts - X-Ray Flares

Solar activity has been High with one X-flare, peaking at X2.0 at 23/1927 UTC, most likely from AR4001 over the NW limb.

There are now nine sunspot regions on the visible disc. AR4001 was likely responsible for the largest flare of the last 24 hours, but is no longer visible on the northwest limb. The risk from this region will ease over the next 24 hours. Otherwise, the most notable regions remain AR3998 in the southwest quadrant and AR4000 in the northwest quadrant. AR3998 has shown spot development, increasing in penumbral area, with mixed polarities in the intermediate portion. However, it does not currently have a clear delta spot. AR4000 developed rapidly at first although this has now stalled, showing some slight decay in its intermediate spots. However, there remains a delta region in the trailing portion. AR3996 appears to be in slight decay. The other regions on the disc do not currently appear particularly complex, although the regions near the east limb are still difficult to assess accurately due to the foreshortening here.

Moderate solar activity is forecast, with isolated M-flares considered likely and a slight chance of X-flares. There are possibly a couple of further regions due to return from the far side in the coming days, but far side seismographs are not detecting any significant regions near the east limb. As such the probabilities have been kept flat through this period pending further developments.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	70	70	70
Very Active	R3-R5 (X Class)	Yes	10	10	10	10

Figure 3: GOES-16 & -18 X-ray flux.

Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux has been very slightly raised, likely due to either an M3 flare from AR4000 or the coincident west limb filament eruption on 21 Feb, but flux values are steadily declining to near normal background levels. The X2.0 flare from over the NW limb may give an increased risk of the S1/Minor radiation storm threshold being met, with the probabilities raised accordingly on Day 1 (24 Feb).

Overall, proton flux has a chance of reaching S1 levels in response to the recent X2.0 flare. In the absence of any increase from this event, proton flux is most likely to remain at background levels, but with a slight chance of rising in response to any further large flares, the risk mainly from AR3996, AR3998, AR4000, or perhaps AR4001 again.

Radiation Storms	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	50	15	15	15
Very Active	$\geq \text{S3}^*$	No	2	1	1	1
* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and/or $50 \text{ MeV} \geq 10 \text{ pfu}$. ($\text{pfu} = \text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)						

High Energy Electrons ($\geq 2\text{MeV}$)

High energy electron flux, as observed at GOES-16 is at background to diurnally moderate levels. Slow solar winds have become established after the HSS from CH15, and since then there has been no significant rise in electron flux at GEO, so it now seems unlikely that diurnally high peaks will be reached. In addition, with potential CME influence in the forecast on Day 1 (24 Feb), this could help to suppress electron flux during the period.

The associated 24 hour fluence is currently below the Active level, with a slight declining trend, and fluence is expected to continue to ease. MOSWOC REFM is suggesting a gradual decline in fluence, which matches up with observations and seems like reasonable guidance at this time.

GEO Electron Environment	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2\text{ MeV}$ $\geq 1\times 10^8$	No	1	1	1	1
Very Active	$\geq 2\text{ MeV}$ $\geq 1\times 10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM

